

WHAT IS CLAIMED IS:

1. Apparatus for analysis of a complex system comprising elements, to determine the effective elements of a system in carrying out a given task, the apparatus comprising:

a sampler for sampling a system to which successive silencing operations comprising silencing elements and combinations of elements of the system are applied under said given task to obtain sampling results,

a predictor for providing predictions for predicting results for the given task for further element silencing combinations, and

a contributions calculator for using said measured results and said predicted results to generate Shapley value predictions for said elements as indicators of an effectiveness of a respective element in carrying out the given task.

2. The apparatus of claim 1, wherein said predictor is trainable on said sampling results.

3. The apparatus of claim 2, wherein said predictor is operable to complete said measured results by predicting further results to produce a complete overall set of measured and predicted results representing all possible silencing combinations of said elements in said system, said complete set of outputs being usable within said contributions calculator for calculations of Shapley values for each element.

4. The apparatus of claim 1, wherein said predictor is Functional Contribution Analysis (FCA).

5. The apparatus of claim 1, wherein said predictor is projection pursuit regression (PPR).

6. The apparatus of claim 2, further comprising a statistical deviation calculator, associated with at least one of said system analyzer and said predictor, and configured to use confidence interval analysis to indicate a sufficient number of results to enable statistically meaningful Shapley values to be calculated.

7. The apparatus of claim 1, wherein said complex system is any one of an economic system, a biological system, a virtual system, a physical system, a chemical system, a control system, a system comprising neural networks, neurological system, a biochemical system, a genetic system, an electronic system, and a cost-based system.

8. The apparatus of claim 1, wherein said successive silencing operations are any one of a group comprising lesion operations, reversible lesion operations, multi-gene knockout operations, mutation operations, RNA interference operations, Transcranial Magnetic Stimulation (TMA) operations, physical shutdown operations, biochemical interference activity, perturbation analysis, and bioelectrical interference activity.

9. The apparatus of claim 1, further comprising an eliminator, located between said predictor and said contributions calculator for using outputs of said contributions calculator to identify elements providing minimal contribution, to eliminate said elements at said predictor and to operate said predictor to make new predictions for combinations of elements determined to be significant, thereby to provide a two-stage analysis process.

10. Method for analysis of a complex system comprising elements to determine the effective elements of a system in carrying out a given task, the method comprising:

carrying out successive silencing operations comprising silencing elements and combinations of elements of the system,

measuring results of the given task under respective silencing operations,

providing predictions for predicting results for the given task for further element silencing combinations, and

using said measured results and said predicted results to generate Shapley value predictions for said elements as indicators of an effectiveness of a respective element in carrying out the given task.

11. Apparatus for genomic analysis of a genetic system comprising a plurality of genetic elements, each element being a genetic element being silenceable via genetic knockout operations to determine the effective elements of a system in carrying out a given task, the apparatus comprising:

genetic knockout unit for carrying out successive silencing operations comprising silencing combinations of at least one of selected genetic elements,

a sampler for measuring results of the given task following a given silencing combination,

a predictor for providing predictions for predicting results for the given task for further element silencing combinations, and

a contributions calculator for using said measured results and said predicted results to generate Shapley value predictions for said genetic elements as indicators of an effectiveness of a respective genetic element in carrying out the given task.

12. The apparatus of claim 11, wherein said genetic knockout operation is silencing of a corresponding RNA pathway and said genetic knockout unit is an RNA interference unit.

13. The apparatus of claim 11, wherein said genetic knockout operation is mutation and said genetic knockout unit is a mutator.

14. A method for pruning a neural network comprising:

carrying out successive silencing operations on combinations of elements of said neural network,

using a Shapley value predictor for predicting Shapley values for elements of said neural network, and

pruning said network by successively removing elements having lowest contribution values to said network as indicated by their corresponding Shapley values, until a stop condition is reached.